

A Feasibility Study of MRI Guided Pre-Plan Using Advanced Gynecological Applicator Venezia

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Introduction

The Venezia advanced applicator (Elekta Inc., Stockholm, Sweden) is a gynecological brachytherapy applicator that offers the physicians the flexibility to expand from traditional tandem and ring/ovoid geometry to interstitial implants to cover tumors with more irregular dimension and/or shape. However, it is difficult to know the ideal needle insertion path and its depth without trial-and-error on the first day of implant. In this study, we evaluated the feasibility of a pre-plan technique to utilize MRI and CT for a more efficient needle insertion workflow using the Venezia applicators. This proposed workflow not only facilitates needle insertion mapping and depths, it also provides opportunity to assess the ideal applicator size and combinations prior to the 1st fraction of implant.

Workflow

Acquire a set of T2 MRI with Venezia applicator in place with zero tandem* (blue arrow) and define high-risk clinical target volume (HRCTV, red arrow) on the MRI.

Figure 1 (a)

Acquire a CT set of the assembled Venezia applicator including the perineal template† (green arrow).

Figure 1 (b)

Register the MRI (HRCTV, red arrow) and the CT (applicator only, blue arrow).

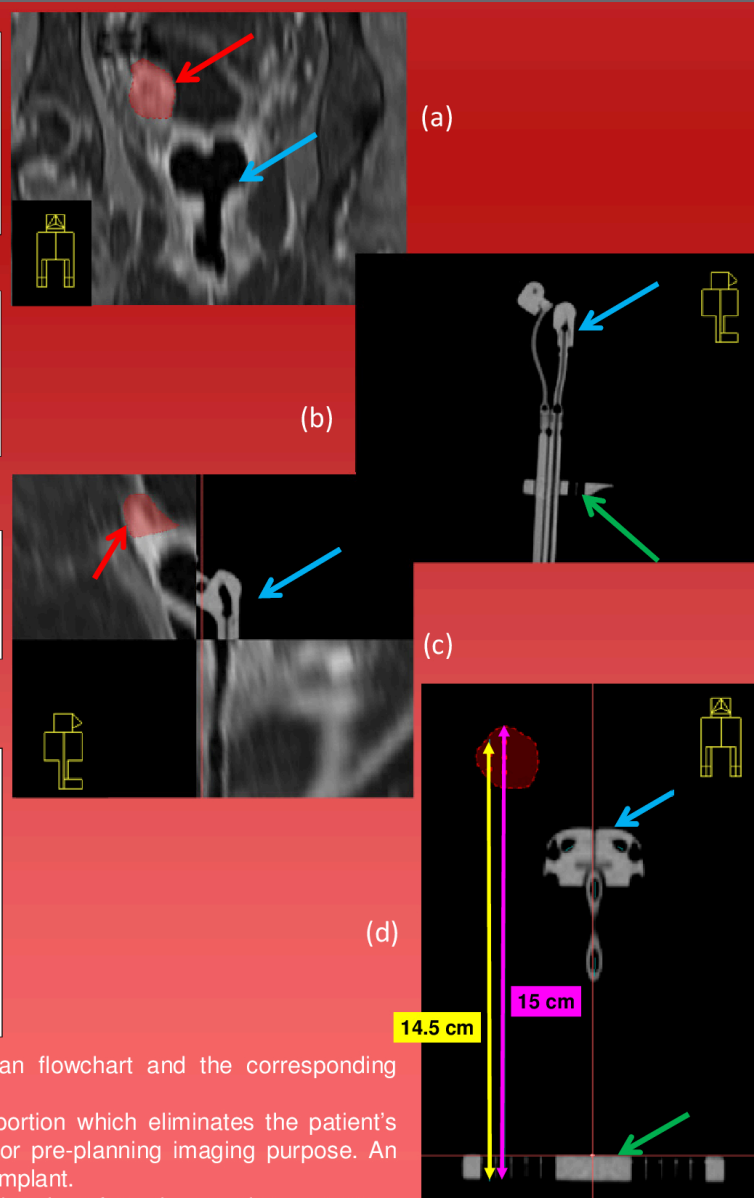
Figure 1 (c)

In the treatment planning system, determine needle placements based on the geometry of the HRCTV with the applicator on the registered image. In Figure 1 (d), two of the needle projections through the template were shown from the pre-plan; the measured needle depths, 14.5 and 15 cm, were also displayed.

Figure 1: Proposed Venezia interstitial implant pre-plan flowchart and the corresponding images.

*Zero tandem is the tandem without uterine insertion portion which eliminates the patient's discomfort but provides essential applicator geometry for pre-planning imaging purpose. An appropriate uterine tandem will be utilized for the actual implant.

†This CT set is applicator only to reduce additional imaging dose from the pre-plan process to the patient.



Clinical Experience

A 63 year old patient with spindle cell sarcoma with vaginal recurrence was considered for high-dose-rate interstitial brachytherapy using Venezia applicator. Multiple versions of pre-plans were created in the treatment planning system (TPS), using 10, 11, and 12 needles. The final pre-plan version with 10 needles was chosen based on the following criteria: (1) appropriate needle placement within the HRCTV; (2) appropriate needle spacing (~ 1cm); (3) appropriate number of dwell positions – if only one dwell position in a needle, considered removing it; and (4) needles with potential to perforate uterine vessels or other organs at risks were removed. The final dose distribution on MRI images for the proposed pre-plan were shown in Figure 2. The needle map based on the 10 needle (green dots) pre-plan was displayed in Figure 3. This needle map could be utilized on the day of actual implantation as an anatomy based starting point reference.

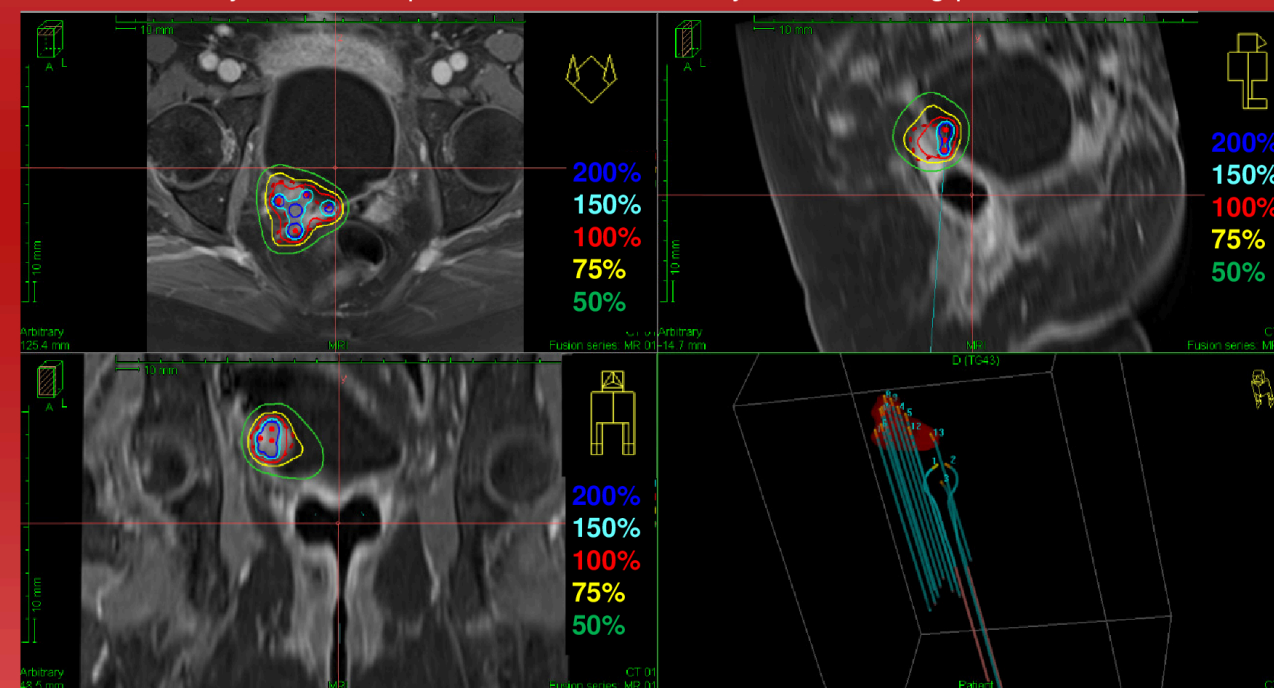


Figure 2: Final dose distribution based on the 10-needle pre-plan showed reasonable HRCTV (red dash line) coverage.

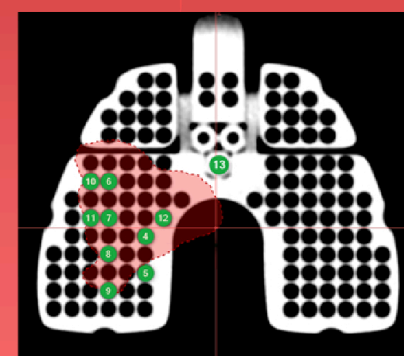


Figure 3: Pre-plan needle placement. Green dots – needle position based on the template. Red shaded area – HRCTV projection on the template.

Conclusion

This case study demonstrated the proposed pre-plan workflow utilizing both MRI and CT images for potential gynecological interstitial implant using Venezia applicator is feasible.